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RAPID COMMUNICATION

A basal bird from the Campanian (Late Cretaceous) of Dinosaur Provincial Park (Alberta, Canada)

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Abstract

A fragmentary bone from the Dinosaur Park Formation (Campanian) of Dinosaur Provincial Park (Alberta, Canada), originally described as a pterosaur tibiotarsus, is reinterpreted as the distal end of the tibiotarsus of a basal bird, probably an enantiornithine, on the basis of several distinctive characters. It is the first report of such a bird from the Dinosaur Park Formation and shows that this group was present, together with various more derived ornithurines, in the relatively high-latitude environments of Late Cretaceous western Canada.

Keywords: Cretaceous, Campanian, Alberta, Canada, Aves, Enantiornithes.

1. Introduction

Although the Dinosaur Park Formation of southeastern Alberta (Canada) has yielded one of the most diverse vertebrate assemblages of Late Cretaceous age (Currie & Koppelhus, 2005), 'bird fossils are under-represented in the fossil collections from the Park' (Currie, 2005, p. 390). Until recently, only small isolated teeth probably pertaining to birds (Sankey *et al.* 2002) and three neornithine birds represented by isolated bones (Hope, 2002) had been reported from Dinosaur Provincial Park. Longrich (2009) has added new ornithurine specimens to this list in his description of an ornithurine-dominated avifauna from the Campanian of Alberta, based on material from Dinosaur Provincial Park and other localities in southern Alberta. In the course of an examination of the pterosaur material from the Dinosaur Park Formation in the collections of the Royal Tyrrell Museum of Palaeontology (Drumheller, Alberta; abbreviated as TMP), it became apparent that a specimen previously described as a fragmentary pterosaur tibiotarsus (Currie & Padian, 1983) is in fact the distal end of an avian tibiotarsus. This additional bird specimen is redescribed below. Its interest lies in the fact that it probably belongs to an enantiornithine bird, a member of a basal avian group that had not previously been reported from the Late Cretaceous of Alberta.

2. Geographical and geological setting

According to Currie & Padian (1983), the specimen (TMP 79.14.247) was collected in 1979 by Donna Lee Ost in Dinosaur Provincial Park, in southeastern Alberta (see Currie & Padian, 1983 for details). The label indicates that it comes from quarry 147. It was originally described as coming from the Judith River (Oldman) Formation. The currently used stratigraphical nomenclature for Dinosaur Provincial Park recognizes a Late Campanian Dinosaur Park Formation, which is distinct from the Oldman Formation and overlies it (Eberth, 2005; Braman & Brinkman, 2009). Specimen TMP 79.14.247 comes from the lower half of the Dinosaur Park Formation, in which quarry 147 is located, and was collected from a channel sandstone (D. Eberth, pers. comm.; see also CD-ROM accompanying Currie & Koppelhus, 2005). The Dinosaur Park Formation was deposited in a coastal plain environment (Eberth, 2005) and has yielded a very abundant and diverse vertebrate assemblage (Currie & Koppelhus, 2005). Its age is well constrained as late Campanian, about 75 Ma (Eberth, 2005; Braman & Brinkman, 2009).

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3. Description and identification

Specimen TMP 79.14.247 was originally described as the distal end of the right tibiotarsus of a pterosaur by Currie & Padian (2003). Azhdarchid pterosaurs are well represented in the Dinosaur Park Formation of Alberta (Godfrey & Currie, 2005). However, as shown below, TMP 79.14.247 differs in important respects from a pterosaur tibiotarsus and shows a number of characters indicating that it belongs to a basal bird, very likely an enantiornithine.

The bone fragment is the distal end of a right tibiotarsus, consisting of the fused tibia and proximal tarsals (Fig. 1). The bone is 11 mm in width at the level of the condyles, which suggests a bird roughly the size of a small goose (*Anser anser*). No sutures are visible between these elements. The pulley-shaped distal articulation consists of two rounded more or less cylindrical condyles, which are markedly asymmetrical, the medial condyle being much wider than the lateral condyle. The condyles project markedly in a cranial direction and are separated by a deep sulcus. The lateral face of the lateral condyle shows a tubercle in its caudal portion and there is a ridge on its caudal margin. The medial face of the medial condyle shows a central tubercle (the epicondyle), with a small cup-like depression cranial to it. At its proximal margin, the bulbous medial condyle is separated from the shaft by a deep narrow slit, which is a continuation of the intercondylar sulcus, with a deep pit at its bottom. The cranial face of the shaft shows a well-marked oblique ridge issuing from above the lateral part of the median condyle and directed proximomedially. This ridge marks the lateral limit of the ascending process of the astragalus, which is strongly fused to the shaft. A fainter and shorter ridge issuing from above the medial margin of the medial condyle marks the

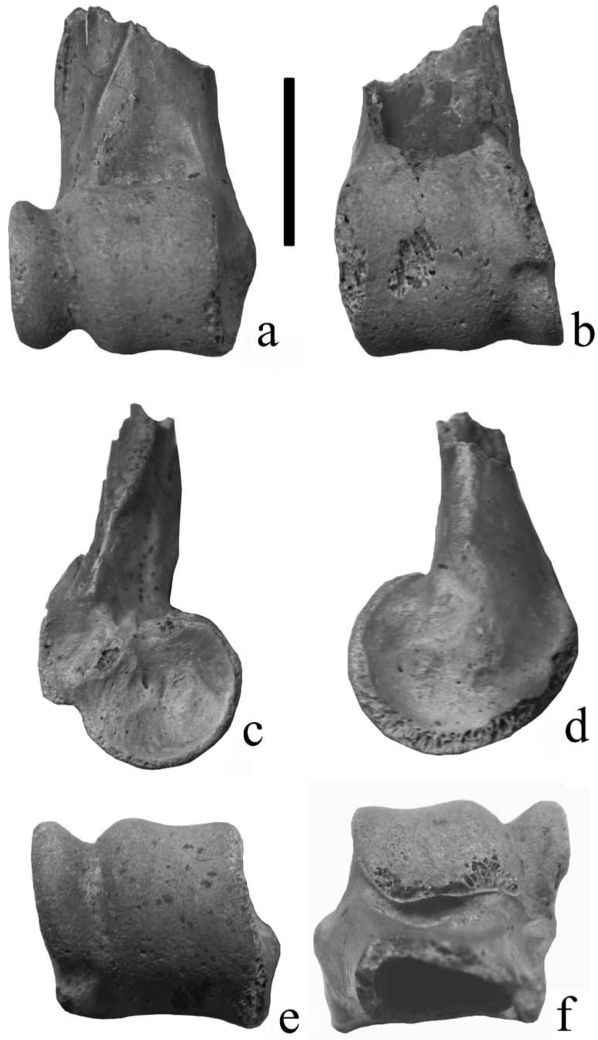

Figure 1. Distal end of the right tibiotarsus of a basal bird, probably an enantiornithine, from the Dinosaur Park Formation (Campanian) of Dinosaur Provincial Park (Alberta, Canada), Royal Tyrrell Museum of Palaeontology, Drumheller, TMP 79.14.247, in cranial (a), caudal (b), lateral (c), medial (d), distal (e) and proximal (f) views. Scale bar: 10 mm.

medial boundary of the process. The surface of the process is concave in its distal part. Above this concave area, a small tubercle is present. The lateral margin of the shaft bears a distinct ridge which ends some distance proximal to the lateral condyle. At the level of the proximal break, the shaft is subrectangular in cross-section and hollow, with bony walls which are less than 1 mm in thickness.

As mentioned above, Currie & Padian (1983) identified TMP 79.14.247 as the distal end of a pterosaur tibiotarsus. However, several characters show that this identification must be revised. While fusion of the proximal tarsals with the tibia is a common occurrence in Cretaceous pterosaurs (Wellnhofer, 1978, 1991), at least in adults (Kellner, 2004), the condyles usually do not show the conspicuous size disparity seen in the specimen from Dinosaur Provincial Park. In *Pteranodon*, for instance, they are subequal in size (Bennett, 2001). More importantly, the astragalus of pterosaurs does not possess an ascending process (Kellner, 2004). The presence of this feature in the bone from Dinosaur Provincial Park indicates that it cannot belong to a pterosaur.

An ascending process of the astragalus that is strongly fused to the shaft of the tibia, but still discernible, is a feature of the tibiotarsus of various basal birds, notably *Vorona berivotrensis*, from the Late Cretaceous of Madagascar (Forster *et al.* 2002) and various enantiornithines (Kurochkin, 1996; Buffetaut, Mechin & Mechin-Salessy, 2000; Chiappe & Walker, 2002; Chiappe, Ji & Ji, 2007). The presence of a tubercle on the ascending process was reported in *Nanantius valifanovi* (sometimes referred to *Gobipteryx*: Chiappe & Walker, 2002), from the Late Cretaceous of Mongolia, by Kurochkin (1996), who considered this feature as a diagnostic character of Enantiornithes, but, as noted by Buffetaut, Mechin & Mechin-Salessy (2000), it also occurs in *Confuciusornis* (Chiappe *et al.* 1999). A similar tubercle is present on the enantiornithine tibiotarsus from the Late Cretaceous of Provence described by Buffetaut, Mechin & Mechin-Salessy (2000). The size disparity between the condyles, the medial condyle being much broader than the lateral one, is common in basal birds (Buffetaut, Mechin & Mechin-Salessy, 2000; Chiappe, 2002; Chiappe & Walker, 2002), including *Confuciusornis*, *Vorona, Patagopteryx* and enantiornithines. There is therefore no doubt that the fragmentary right tibiotarsus from the Dinosaur Park Formation belongs to a basal bird. A more precise identification may be based on the presence (Fig. 1g) of a character considered as a synapomorphy of Euenantiornithines by Chiappe & Walker (2002, pp. 256, 263), although it does not appear in the larger character lists for Mesozoic birds provided by Gao *et al.* (2008) and O'Connor *et al.* (2009), namely, a 'very narrow, deep intercondylar sulcus on tibiotarsus that proximally undercuts condyles' (Fig. 1f). On this basis, the tibiotarsus fragment from Dinosaur Provincial Park may be referred to the Euenantiornithines.

A more precise identification is difficult on the basis of such a fragmentary specimen. A small number of Late Cretaceous well-preserved, relatively uncrushed euenantiornithine tibiotarsi have been described, notably from Argentina (Chiappe, 1993; Chiappe & Walker, 2002), Mongolia (Kurochkin, 1996) and France (Buffetaut, Mechin & Mechin-Salessy, 2000). The still visible ascending process, bearing a tubercle, of the Canadian form is more reminiscent of the Mongolian and French fossils than of the Argentine specimens (*Lectavis bretincola*, *Soroavisaurus australis*), but the phylogenetic and systematic meaning of this is unclear. The specimen from Dinosaur Provincial Park can therefore very probably be referred to as Euenantiornithes indet.

4. Conclusions

The identification of TMP 79.14.247 as a basal bird, in all likelihood an enantiornithine, adds a new taxon to the avifauna from the Campanian of Alberta. The presence of this basal bird modifies our image of this avifauna. Longrich (2009, p. 174) noted about the composition of this assemblage: 'The absence of enantiornithines is even more striking: an exhaustive search of Tyrrell and University of Alberta collections has failed to uncover a single element which can be confidently referred to the group', and concluded that 'if enantiornithines were present in Alberta, then they must have been an uncommon component of the fauna'. TMP 79.14.247 shows that basal birds were in fact present. Whether they really were uncommon is a moot point. In view of the still relatively small number of bird bones currently known from the Campanian of Alberta, it is difficult to make valid pronouncements about the relative abundance of enantiornithines in this avifauna, but it now seems that this group of basal birds was part of it, although it may have been outnumbered by ornithurines. The occurrence of a basal bird in the Dinosaur Park Formation of Alberta does not really come as a surprise, as

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enantiornithines were already known from the roughly coeval Two Medicine Formation of neighbouring Montana, with *Avisaurus gloriae* (Varrichio & Chiappe, 1995), based on a tarsometatarsus that does not allow direct comparison with the Canadian fossil. A somewhat later (late Maastrichtian) enantiornithine specimen (*Avisaurus archibaldi*) is known from the Hell Creek Formation of Montana (Brett-Surman & Paul, 1985; Chiappe, 1993). In Canada itself, enantiornithine remains were reported from the Campanian Northumberland Formation of Hornby Island, British Columbia (Morrison, Dyke & Chiappe, 2005), but they come from a different palaeogeographical and depositional setting, having been found in marine sediments containing an Indo-Pacific mollusc fauna.

Although the discovery of a probable enantiornithine in the Dinosaur Park Formation does not necessarily invalidate Longrich's hypotheses (Longrich, 2009) about the dominance of ornithurines in the Campanian of Alberta and its possible climatic causes (namely, that ornithurines were better able to cope with high-latitude environments than enantiornithines), it does show that basal birds coexisted with more modern birds at relatively high latitudes. With the exception of marine forms such as Hesperornithiformes and Ichthyornithiformes, the current record of Late Cretaceous birds, in North America as elsewhere, remains scanty and largely based on fragmentary material, and a better understanding of the biogeographical and ecological relationships between different avian groups during that time interval will ultimately depend on the discovery of more complete and more abundant material.

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